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VOL. XXIX. AUGUST 1922 No. 4

POSSIBLE PEDOGENESIS IN THE BLOW-FLY, *Calliphora erythrocephala* MEIGEN.

By G. H. Parker.

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In the early autumn of 1918 I prepared a number of cultures of larvae of the common blow-fly, *Calliphora erythrocephala*, and in several of these cultures the numbers of maggots seemed to exceed considerably the numbers of eggs that had been introduced. This aroused the suspicion that some unusual form of multiplication such as polyembryony or pedogenesis was occuring and to test this definite experiments were attempted.

On November 25, 1918, thirty bottles closed with aluminum caps through each of which a minute hole had been punched, were supplied with small pieces of fish-meat carefully inspected to see that they carried no fly eggs. In each of twenty of these bottles a single blow-fly egg was placed, ten bottles having been retained as checks. On December 9, 1918, all these bottles were carefully examined. Seven of the infected bottles contained no maggots, ten contained each one maggot, one contained two maggots, another three, and a third four. One of the check bottles, however, contained nine small maggots showing that the procedure that had been followed was defective. Either unseen eggs had been accidentally introduced with the meat, or flies had slipped eggs into the bottle through the small hole in the cap. Hence the increased numbers in several of the infected bottles could not be said to be due to multiplication within the bottle itself and this type of test was, therefore, abandoned.

In the spring of 1919, with the return of the flies, a new procedure was employed. Fifty clean quart jars were prepared by pouring into them enough coarse sand to cover their bottoms. This sand had previously been sterilized by baking. Into each

jar was then introduced a small glass beaker containing a bit of carefully inspected fish meat. The jar was then closed by having mosquito netting tied over its open end and by setting in place on this netting the glass cover of the jar without, however, clamping it down. Thus it was believed that the jars were effectively protected against the introduction of eggs from the outside and that the gases generated by the decomposing meat within could escape. Fluid could be introduced into the jar by removing the glass top and pouring it in through the meshes of the netting without, however, allowing the accidental entrance or escape of flies should there be any at hand. The fish-meat in the jars was not sterilized by cooking, for it was found to decompose much more freely and satisfactorily when uncooked.

The fifty jars thus prepared were set aside April 2, 1919, and allowed to stand twenty days. After this period a searching inspection showed that none of them contained maggots. These would surely have been seen had they been introduced by accident with the meat. On April 23 twenty-five jars were infected each with a single fly egg and the remaining twenty-five were held unchanged as checks. From time to time during the next few weeks a small amount of distilled water was poured into each jar but otherwise the jars remained closed for this period. On May 14 the contents of the jars were examined. The twenty-five jars used as checks contained no evidence of flies. In the twenty-five infected jars seven were without maggots or pupæ and eighteen contained each a single pupa. Thus there was no evidence of increase. A second trial carried out in the same way in May and June yielded similar results.

In the autumn of 1919 tests were resumed. These were of two kinds, one to ascertain what hatched from an individual egg and the other to find out what came from the larva. To determine what came from a single egg, twenty eggs on October 29 were put with a few drops of water each into a separate Syracuse watch-glass. Twelve of these had hatched by October 30 and each produced a single larva. Eight failed to hatch probably because of mechanical injury. Between October and the end of

December, 1919, 502 eggs were hatched in this way and in no instance did an egg produce more than a single larva. It was therefore concluded that Calliphora gave no evidence of polyembryony such as has been found so abundantly in certain hymenopters.

To test again the possible production of maggots from other maggots, the experimental procedure of April 2, 1919, was repeated. On October 2, fifty jars were set up with fish-meat. They were examined on October 28 and were found to contain no maggots. On the next day into each of twenty-five of these jars a single newly hatched maggot was introduced and the remaining twenty-five were kept as checks. On November 10 an examination of the jars showed no maggots in the twenty-five check jars, no maggots in three of the infected jars, probably because of accidental death, one maggot each in twenty of the infected jars, eight in one infected jar, and twenty-one in another. The maggots in the last two jars were carried on to pupation and hatched. All proved to be Calliphora erythrocephala. Of the eight in the first jar, five were males and three were females. Of the twenty-one in the second jar, five failed to hatch, nine emerged as males and seven as females.

On October 18, a second set of fifty jars was started in the same way as in the preceding test. On November 15 these jars were examined and found to contain no maggots showing that they had not been accidentally infected. Into each of twenty-five of them a single newly hatched maggot was introduced and the jar closed. On November 26 pupation was completed and an examination of the set showed that the twenty-five check jars were without pupæ as well as six of the infected jars; eighteen of the infected jars contained each a pupa, and one contained seven. These seven were subsequently hatched and all proved to be *Calliphora erythrocephala*, four females and three males.

The tests of October 2 and October 18 were carried out with such precautions that it seems impossible that the results could be due to accident. The increases observed have always occured in the autumn and never in the spring and I am, therefore, led to believe that in October and November or even later

Calliphora erythrocephala occasionally multiplies in an unusual way, and that this way is not polyembryony but pedogenesis.

At the appropriate season it is planned to conduct an investigation of the maggots of Calliphora to ascertain whether they contain parthenogenetic eggs or young. If they do, the blow-fly will constitute another instance among insects of pedogenesis. The original and best known case of this kind is that of the fly Miastor and its allies discovered by Wagner (1862, 1865) and studied by Kahle (1908) and by Felt (1911). Less clear is the case of Chironomus reported by Grimm (1870) and of its near ally Tanytarsus observed by Johannsen (1910). All these are Dipterans but within a few years Barber (1913a, 1913b) has claimed an instance, Micromalthus, among the beetles. The wingless female aphids must also be regarded as pedogenetic. Possibly this form of reproduction is more generally spread among insects than was originally supposed.

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ON SOME TROPHOBIOTIC COCCIDÆ FROM BRITISH GUIANA.[1] [2]

By Harold Morrison.

Bureau of Entomology, Washington, D. C.

Representatives of all of the species of Coccidæ discussed in the following pages were collected by Dr. W. M. Wheeler of Bussey Institution, Harvard University, in the course of his investigatoins at the Tropical Research Station of the New York Zoological Society in British Guiana and were recently submitted to the writer for determination. Critical study of the material available for examination in the National Collection of Coccidæ has shown that two of these species have also been collected in certain of the West Indian islands by the writer and others, and this opportunity has been taken to add these records to those from British Guiana.

SUBFAMILY MARGARODINÆ

GENUS STIGMACOCCUS HEMPEL.

Stigmacoccus asper (Hempel)

A number of specimens of this species were received with the following note by Dr. Wheeler:

"No. 757. Kartabo, B. G. Sept 5, 1920. Taken from a huge colony of *Crematogaster* sp. (near *acuta* Fabr.) nesting under bark of a large standing tree. The nest covered an area of more than 12 square feet and contained several hundred coccids enveloped in black carton. The young coccids were golden yellow, the older darker."

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[2]—The intimate relations described—as existing between ants on the one hand and the various Homoptera—on the other hand—have a common peculiarity. In all of these cases the ants are supplied with food in the form of an excretion or secretion elaborated from the juices of the plants. Wasmann has therefore designated these relationships as *trophobiosis* to distinguish them from the cases of myrmecophily proper—." (Wheeler, Ants, etc. New York, Columbia Univ. Press, 1013, p. 360).

Only preadult specimens and one partially molted adult could be located in the material submitted, and mounts of such specimens have been carefully compared with the corresponding stages from cotype material received by the Bureau of Entomology from Prof. Adolph Hempel, the describer of the species. Some slight differences in the length and stoutness of the heavy spines crowding the derm of the preadult have been observed, but no other morphological characters that even suggest that the specimens from British Guiana represent another species than *S. asper*. In the absence of other stages, as larvae and well developed females and males, in which specific differences might appear, it seems best to regard the specimens from British Guiana as Hempel's species.

SUBFAMILY DACTYLOPIINÆ

GENUS PSEUDOCOCCUS WESTWOOD

Pseudococcus bromeliae (Bouché)

References.—Ferris, Journ. Econ. Ent. vol. 12. no. 4, Aug. 1919, p. 196—Morrison, Phil. Journ. Sci. vol. 17, no. 2, Aug. 1920, p. 173.—Cockerell, Science n.s. vol. 55, no. 1492, 1922, p. 351.

After extended critical study the writer has placed as this species the material from Dr. Wheeler's collections listed below together with his notes on the same.

"No. 116. Kartabo, B. G. July 17, 1920. In the cavities of the stems of a seedling *Cecropia* (*angulata* I. W. Bailey). The ants belonged to a black species of *Azteca* not yet identified."

"No. 247. Kartabo, B. G. July 23, 1920. The coccids were in the hollow bases of the leaf-petioles of a *Tachigalia paniculata* Aublet with a black species of *Azteca* (*Azteca foveiceps* Wheeler)."

"No. 367. Kartabo, B. G. Aug. 3, 1920. In node-like stem swellings of *Cordia nodosa* Lani. var. *hispidissima* Freser, with the ant *Brachymyrmex* sp. (probably *heeri* Forel)."

No number. "Kartabo, July-Aug. 1920. In the swellings

of the stems of *Cordia nodosa* Lani. var. *hispidissima* Freser, with *Allomerus octoarticulatus* Mayr, the typical ant of this myrmecophyte."

Nos. 209 and 175 have previously been identified in connection with Dr. Wheeler's extended account of the curious social beetles which he found in this region.

An exmination of these specimens in comparison with an extensive series of individuals from many other tropical and subtropical areas has indicated that this species is subject to a certain degree of variation in respect to the structural characters that are at present regarded as of taxonomic value, this variation occuring particularly in the number of spines in the different marginal cerarii, the shape of the ventral chitinized area at the caudal apex of the body, and the number of antennal segments.

In the specimens collected by Dr. Wheeler the cerarian spines average slightly more numerous for corresponding cerarii than in typical forms from pineapple, that is, for example, in the same cerarius in ten specimens instead of, say, four having four spines and the other six, three spines each, the proportions may be six with four spines and four with three spines to each. The chitinized ventral thickening in nearly all of the specimens from pineapple is irregularly quadrate, at most only slightly longer than wide, but in the specimens from Dr. Wheeler, while the variation is marked, the average shape of each thickening is distinctly elongate, in this respect more nearly resembling the shape as figured by Ferris (ref. cited) for the species than the usual shape in the specimens from pineapple. The accompanying figure indicates this variation quite clearly. Finally, *P. bromeliæ* normally has 8-segmented antennæ, while in a majority of the specimens sent by Dr. Wheeler these are 7-segmented; however, since these specimens show a range of from six to eight segments there seems no ground for attaching any taxonomic significance to the presence of one less segment in the majority of the antennæ examined.

Prof. Cockerell (ref. cited) has recently called attention to the fact that the identification by modern coccidologists of the mealybug commonly occuring on pineapple as the "Coccus

bromeliæ" of Bouché rests on a very unstable basis due to the ambiguity of the original description. As a matter of fact, it appears to be entirely impossible to determine positively what species was described by Bouché under this name, and our present notion of the species really dates from Signoret's redescription in 1875. As Prof. Cockerell suggests, his "*Dactylopius brevipes*" described from Jamaica on pineapple is identical with the species at present recognized as *P. bromeliæ*, but as *Pseudococcus brevipes* has never attained any standing among coccid workers, while several at present recognize and identify a certain mealybug as *P. bromeliæ*, the writer has preferred to retain the older name regardless of the uncertainty as to what was actually described by Bouché, at least until his species is clearly shown to be something other than the one at present given the name *bromeliæ*.

Pseudococcus rotundus sp. nov.

Occuring in cavities in stems of the host, attended by ants.

Adult Female.—All specimens available preserved in liquid, so nothing regarding normal external appearance can be given; maximum length as mounted 3 mm., maximum width 2.75 mm., specimens in preservative proportionately somewhat more elongate, flattened beneath but strongly convex above; derm clearing completely on treating with potassium hydroxide, except for the appendages and the ventral chitinized areas; antennae normally 8-segmented, not unusual, the range of measurements in microns of segments in four individuals as follows: I, 72-79; II, 68-79; III, 54-64; IV, 36-46; V. 46-54; VI, 43-57; VII, 50-54; VIII, 107-114; legs normal, stout, hind femur and tibia with numerous tiny pores, those on femur frequently clustered, digitules probably normal, but all injured, claw stout, without denticle; beak elongate triangular, with a narrow basal collar and two much larger, distinct segments; with the usual two pairs of dorsal ostioles; normally with 17 pairs of cerarii each composed of spines with accessory setæ and a cluster

of triangular pores, but some of those on the thorax often greatly reduced or entirely wanting; the numbers of spines in the different cerarii showing the following range in four specimens: I (anterior), 3-4; II, 3-4; III, 2-3; IV, 0-3; V, 1-3; VI, 0-2; VII, 1-5; VIII, 0-2,; IX, 2-4; X, 2-4; XI, 3-4; XII, 2-4; XIII, 2-4; XIV, 4-5; XV, 4-5; XVI, 6-9; XVII (anal lobe). 11-22; in mounted specimens, with the posterior two or three cerarii on each side dorsal and the remainder ventral; apex of abdomen not produced into lobes; ventral chitinous thickening elongate, bearing several setæ; apical setæ about 145μ long; longest and anal ring seta about 93μ long; anal ring of normal form and construction, with inner and outer rows of pores but with the setæ more numerous than in other species of the genus, there being three larger primary setæ and from five to ten smaller supplementary setæ on each half of the ring,the smaller setæ about half the length of the larger; dorsally with small triangular pores only, these scattered rather uniformly over the surface except along the body margin and at the cerarii where they are more numerous; ventrally with the triangular pores over most of the surface, with a few large, circular, multilocular disk pores around the genital opening, with two median transverse rows of tiny tubular ducts just anterior to these, and with a very few disk pores at the spiracular openings; cerarian spines conical, varying greatly in size; body with numerous, but scattered, slender setæ, these averaging larger dorsally and most abundant along the body margin; with a single, large, quadrate median ventral cicatrix posterior to the hind legs.

Immature Stages.—None available for examination.

This species has been described from five specimens with the following data, according to Dr. Wheeler's notes:

"No. 87. Barakara, B. G. July 15, 1920. In the cavities of the stems of *Cecropia angulata* I. W. Bailey. The ants in this *Cecropia* were a species of *Azteca* not yet identified." (Holotype).

"No. 89. Barakara, B. G. July 15, 1920. In the cavities of

the stems of *Cecropia angulata* I. W. Bailey. The ants belonged to a species of *Azteca* not yet identified." (Paratypes).

No number. "Kartabo, B. G. August 1920. In stems of *Cecropia* with *Azetca* sp. (Paratypes).

The types are in the U. S. National Collection of Coccidæ.

The proliferation of the anal ring setæ in this species is a marked digression from the normal condition in the genus *Pseudococcus* and might be regarded as of sufficient importance to justify the separation of the species from that genus. However, most, if not all, of the other structural characters of the species appear to be characteristic of *Pseudococcus* and it has therefore been placed in that genus.

Genus **Farinococcus,** gen. nov.

A member of the group of which *Pseudococcus* is the typical genus; body oval, antennæ 8-segmented, legs normal, without tiny pores, claw without denticle, beak short triangular, 2-segmented, spiracles stout with large opening and numerous disk pores near mouth, two pairs of dorsal ostioles, cerarii very large, composed of many lanceolate spines, setæ and pores and joined into a continuous band anteriorly; anal lobes not developed, with ventral chitinized thickening and apical seta, anal ring normal, with pores and six setæ, derm with triangular pores dorsally and ventrally and many multilocular disk pores ventrally in genital region, no other pore types, derm with slender setæ dorsally and ventrally, with a single median ventral cicatrix. *Genotype.—Farinoccusus multispinosus, sp. nov.*

This genus diverges from the normal Pseudococcine type most conspicuously in the marked development of the cerarii and the great increase in the number of ventral disk pores, and, to some extent, in the enlargement of the spiracles.

Farinococcus multispinosus sp. nov.

Occuring in cavities in the stems of the host,attended by ants.

Adult female.—Preserved in liquid, so nothing regarding the normal external appearance can be given; color of alcoholic

specimens mostly a light yellow brown; body elongate oval, tapering somewhat behind the middle; average length 3.5 mm., width 2.25 mm; uniformly elongate oval when flattened on a slide; clearing completely, except for appendages and ventral chitinized thickenings, on treating with potassium hydroxide; antennæ normally 8-segmented, not unusual, the range of measurements in microns of the different segments as follows: I, 68-78; II, 64-71; III, 46-53; IV, 28; V, 43-57; VI, 43; VII, 46; VIII, 110-118; legs fairly large, stout, the claw without denticle, the digitules normal, those of claw slightly knobbed at tip, all the legs without tiny pores, but all the coxæ with large distinct basal acrolations, and the femora and tibiæ with similar, but quite indistinct, very large acrolations on the upper halves of each; beak short and stout triangular, two segmented; spiracles large and stout, with a number of disk pores near mouth; with two pairs of heavy, thick-lipped dorsal ostioles, cerarii very strongly developed, those on the posterior abdominal segments narrowly but distinctly isolated from each other, those on the anterior portion of the body united to form a narrow continuous submarginal band made up of hundreds of closely crowded lanceolate spines and triangular pores flanked within by dozens of slender setæ aggregated to form more or less distinct groups; posterior cerarii made up of numerous lanceolate spines (apical about 70, preapical about 85, antepenultimate about 80, fourth from last about 70, next about 65, next about 55) and within each of these ventrally a triangular cluster of setæ and in and around both spine and setæ clusters numerous triangular pores; anal lobes not developed, ventral chitinous thickening heavily chitinized, irregular in shape, enclosing three or four setæ; apical setæ set off just outside the ventral thickening, large and stout as compared with the anal ring setæ, perhaps three times the length of these (broken); anal ring placed dorsally well anterior to the body apex, small, of normal structure, with double pore row and six setæ, the derm on each side of the ring protruding and overlapping to form two longitudinal folds covering the ring, except for a linear or oval median slit; derm dorsally with numerous, uniformly distributed,

triangular pores, ventrally with these pores less numerous, but also uniformly distributed, except at and near the body margin, where they are closely crowded, with numerous large circular multilocular disk pores in a heavy collar around the genital opening and in transverse bands on three segments anterior to genital collar, and quinquelocular disk pores of approximately the same size as the genital pores in numbers at the spiracles; no other pore sorts located; dorsally and ventrally with numbers of scattered, slender, faintly lanceolate setæ; with a single large quadrate median ventral cicatrix posterior to the hind legs.

Preadult female.—In general resembling the adult quite closely, differing in the smaller size, the 7-segmented antennæ, the smaller and less developed spiracles, the reduced numbers of spines, setæ and pores in the cerarii and the very great reduction in the number of ventral disk pores.

No other stages have been available for examination.

This species has been described from four mounted and a few unmounted specimens received from Dr. Wheeler with the following note:

"In the cavities of the stems of *Triplaris surinamensis* Chanc. with *Pseudomyrma* sp. nov. (allied to *Ps. triplaridis* Forel.)"

The types are in the U. S. National Collection of Coccidæ.

GENUS RIPERSIA SIGNORET

This genus is at present merely a convenient dumping ground for those species of mealybugs having the number of antennal segments reduced and the cerarii usually much reduced in number or even wanting. Until the genera of the true mealybugs are based on an adequate morphological foundation, little else can be done with apparently new species than to place them in some such convenient genus as this one, and it is on this basis that the two species described below have been assigned to a position here.

Ripersia petiolicola sp. nov.

Occuring in the hollow bases of the leaf petioles of the host, attended by ants.

Adult Female.—Preserved in liquid leaving none of the secretionary covering available for examination, average length as mounted, 1.3 mm., width 0.875 mm; clearing completely on treating with potassium hydroxide, except for the appendages; antennæ small, placed fairly close together at anterior apex of head, not unusual, normally 6-segmented, but frequently 5 and rarely 4-segmented, the normal measurements in microns ranging as follows: I, 33-39, II, 29-36; III, 36-43; IV, 18-25, V, 18-25; VI, 50-61; legs normal, fairly stout, claw without denticle, hind femur and tibia each with a number of pores; beak triangular, with an incomplete basal collar and two distinct segments; with the usual two pairs of dorsal ostioles; only the two anterior and the two posterior cerarii developed to a definitely recognizable state, the anal pairs with relatively large conical spines, several triangular pores and four to six accessory setæ, the spines in the other recognizable cerarii slender, lanceolate, setalike, the pores less numerous and the accessory setæ fewer or wanting; probably with a more or less complete series of cerarii around the body margin, but these not definitely recognizable, due to the separation of the component parts; anterior cerarii with three spines in each, all others with two; anal lobes slightly indicated, with the apical cerarii underlaid by a faint suggestion of chitinization, with a small, irregular, elongate ventral thickening and an apical seta about 100μ long; largest anal ring seta about 78μ; anal ring normal with the usual pores and six setæ; body, as far as noted, with only two sorts of derm pores, a few multilocular disk pores around the genital opening and smaller triangular pores scattered rather uniformly over the surface, but more numerous along the margin and in the cerarii; body dorsally with some scattered, slender, lanceolate setæ and ventrally with even fewer, distinctly longer and more slender, hair-like setæ; with a single, indistinct, transverse oval ventral cicatrix posterior to the hind legs.

Immature stages.—None available for examination.

This species has been described from three specimens having the following collection data according to Dr. Wheeler's notes:

"No. 247. Kartabo, B. G. July 23, 1920. The coccids were in the hollow bases of the leaf-petioles of a *Tachigalia paniculata* Aublet with a black species of *Azteca* (*Azteca foveiceps* Wheeler.)"

The types are in the U. S. National Collection of Coccidæ.

Ripersia subcorticis sp nov.

Occuring under the bark of the host, attended by ants.

Adult Female.—Preserved in fluid, so nothing regarding the normal external appearance can be given; color of alcoholic specimens ranging from yellow brown to dull purple, but usually with a purple tinge; stout oval, flattened beneath, fairly convex above, average length of mounted specimens 2 mm., width 1.5 mm; clearing completely, except for appendages, on treating with potassium hydroxide; antennæ not unusual, normally 7-segmented, but frequently with six, the range of measurements in microns of those available for examination as follows: I, 47-54; II, 39-50; III, 25-35; IV, 22-32; (III and IV where combined, 57-61), V, 22-29; VI, 28-32; VIII, 71-82; legs normal, the claw without denticle, the hind coxa, but not the femur and tibia, with a number of pores; beak elongate triangular, with an obscure basal collar and two distinct segments; with the usual two pairs of dorsal ostioles; cerarii, as such, not distinctly developed, but with loose marginal or ventral submarginal clusters of slender, conical to slightly lanceolate spines, accompanied by a closer grouping of the small triangular pores, these clusters distinctly isolated on the posterior abdominal segments, but forming an almost continuous but inconspicuous band around the anterior margin of the body; anal lobes barely indicated, the apical seta immediately adjacent to the posterior cluster of spines, length not certain, probably about one and a half times that of the anal ring setæ, without any trace of ventral chitinous thickenings; derm dorsally with only the small tri-

angular disk pores, these scattered rather uniformly over the body surface; ventrally with these pores distributed uniformly except at margin close to and in the "cerarii," with some large circular, multilocular disk pores around the genital opening and in narrow transverse rows on the two segments anterior to this, with a very few, tiny tubular ducts near the genital opening and with much larger, short tubular ducts in clusters just within the "cerarii" on the last five or six abdominal segments, these ranging from four to eight in number in the three clusters anterior to the apical but with only one or rarely two in the one or two anterior groups, the apical group median, usually with about twelve pores in it; derm dorsally with fairly uniformly scattered, very slender, lanceolate setæ, ventrally with longer, slender hair-like setæ; anal ring of normal form, with inner and outer rows of pores and with three primary and usually four smaller, secondary setæ on each half, longest anal ring seta about 110μ; with a single median quadrate ventral cicatrix posterior to the hind legs.

Immature stages.—None available for examination.

This species has been described from four mounted and a few unmounted specimens collected by Dr. Wheeler with the following note:

"No. 79. Barakara, B. G. July 15, 1920. Taken in a large colony of the ant *Tranopelta gilva* Mayr, under the bark of a living tree. The white coccids were present in great numbers over the whole surface of the wood. The ant is usually subterranean, its nest under bark being very exceptional."

The types are in the U. S. National Collection of Coccidæ.

In the multiplication of the anal ring setæ is found a condition exactly comparable to that in *Pseudococcus rotundus*, just described, and it is also similar to the structural modifications of the anal ring in certain other related forms known to be protected and attended by ants, such as *Lachnodiella cecropiæ*, suggesting the possibility that the relationship between the ant and mealybug may have had some influence on the modification in structure.

SUBFAMILY COCCINÆ.

GENUS AKERMES COCKERELL

Following Prof. Newstead's lead, the two species discussed below are continued in the genus *Akermes*, although a comparison of the two with the genotype raises a very serious question as to the correctness of such generic association.

Akermes quinquepori (Newstead)

Reference.—Newstead Bull. Ent. Res. vol. 7, 1917, p. 349.

This species is represented in the material submitted by Dr. Wheeler by three lots of specimens. Dr. Wheeler's notes in regard to these are as follows:

"No. 76. Barakara, B. G. July 15, 1920. Found in a large colony of ants (*Camponotus novogrenadensis* Mayr) which had their nest within that of *Hamitermes excellens* Emerson (MS.) in the bark of a large standing tree. The galleries of the ants interdigitated but did not communicate with those of the termites. The coccids were in the ant galleries and attached in great numbers and in all stages to the surface of the tree itself. It was difficult to remove them without breaking them. A large piece of the inner bark with the coccids was removed with large coccids attached to it. The insects were seen to exude copious drops of clear honeydew from the brown anus on the dorsal surface."

"No. 87. Barakara, B. G. July 15, 1920. In the cavities of a stem of a *Cecropia angulata* I. W. Bailey. The ants in this *Cecropia* were a species of *Azteca* not yet identified."

"No. 164. Kartabo, B. G. July 17, 1920. In the cavities of the stems of a seedling *Cecropia* (name to be supplied later). The ants belonged to a black species of Azteca not yet identified."

Through the kindness of Mr. G. E. Bodkin in locating the same, the writer was given the opportunity of collecting specimens of Prof. Newstead's species from the same tree and the same ant nest that produced the individuals described by him

(Collection Nos. A-733 and A-761), and Dr. Wheeler's specimens have been compared directly with these. The specimens from lots No. 76 and No. 164 are entirely comparable with the topotype specimens except for their slightly larger size. The specimens from lot No. 87 average smaller in size and tend more towards a circular shape. The morphological characters, with the exception of some minor differences in the shape and extent of the various chitinized areas, as the collar surrounding the anal plates, appear to be identical within the limits set by a slight allowance for individual variation, in all the specimens examined.

In addition to the British Guiana records, the writer has collected this species in the grounds of the Department of Agriculture, St. Clair, Port-of-Spain, Trinidad, Nov. 23, 1918 beneath the bark of *Ficus* (*ulmifolia?*) (A-1046), inside the hollowed-out twigs of a large tree of *Pithecolobium saman* (A-1047), and finally on an unknown tree (A-1059), in each case attended by ants.

Some additions to Prof. Newstead's original description may be noted to advantage as aids to the recognition of the species: The claw digitules are present, thread-like, curved, not quite reaching the tip of the claw: the heavy collar at the marginal end of the spiracular complex normally bears two stout, tapering, blunt-tipped, widely separated spines of small size on the outer margin, but these are frequently broken off and the spine base is so placed as to make its recognition very difficult when the spine is missing; the marginal spines are fairly stout, tapering, faintly lanceolate; each anal plate bears from 10 to 15 setæ dorsally, one apical, two subapical, and the remainder scattered over the surface; there are four ventral ridge and four fringe setæ, the latter in two pairs on the edge of the membranous fold beneath the plates; all setæ of the anal plates are slender and of moderate length; anal ring small, with a few large pores and ten setæ; the ventral multilocular disk pores are quite numerous beneath and behind the anal plates and over the posterior portion of the ventral surface, especially near, but not quite at, the body margin, up to the posterior spiracles, but any transverse rows across the middle of the abdominal segments.

anterior to the anal plates are very incomplete or wanting; the "submarginal compound pores" are as described by Newstead, but those just in front of the anterior spiracles are perhaps one-third as large as the two anterior to the posterior spiracles; ventrally there are tiny simple pores in addition to the multilocular disk sort; dorsally there are large, circular, faintly multilocular disk pores, much smaller, circular, heavy-walled simple disk pores and, occasionally, from two to five such pores grouped in a solid heavily chitinized plate.

The larva of this species differs from that of the new species described below most obviously in the length of the hairs in the ventral abdominal rows these in the present species being very minute, while in the new species they are much longer and more conspicuous.

Akermes secretus sp. nov.

Reference.—Coccus sp., van Zwaluwenburg, Jour. Econ. Ent., vol. 10, 1917, p. 515.

Occuring in cavities in the stems or beneath the bark of the host, attended by ants.

Adult female.—Color in life different shades of light reddish or yellowish brown often varying to a hint of lavender or purple brown; color of alcoholic specimens dorsally very pale grayish brown, with more or less distinct linear transverse mottling of dark brown, tiny blackish flecks along margin, a brown area around anal plates and small white spots at the spiracular openings, ventrally with a marginal band of dull brown, the anterior two-thirds of the surface yellow cream, shading off to brown at edges, the ventral abdominal segments about the same color as the dorsum, the whole venter variously mottled and flecked with dark color; maximum length mounted on slide 5.5 mm., width 4 mm.; convexity apparently varying with the development of the ovaries, never strongly convex, shape irregularly oval, body only lightly chitinized, clearing almost completely on treating with potassium hydroxide, but showing faint Saissetia-like areolations in the derm in fully matured

specimens, only the anal plate region and the spiracular areas retaining any marked color; antennæ reduced to short stubs, very indistinctly 4-segmented, bearing a few short slender setæ and several stout blunted setæ at apex; legs also greatly reduced, the different parts not distinguishable, claw present, the claw digitules present, threadlike, curved, extending slightly beyond the apex of the claw; spiracular grooves distinctly deeper than in *quinquepori*, the heavy collar at the inner end perhaps one-third to one-half as wide as in that species and the spiracle itself placed almost immediately below and just inside of the collar rather than at the inner end of a distinct membranous tube as in *quinquepori*; no spiracular spines observed; marginal setæ stout, spinelike, tapering, with swollen bases and acutely pointed tips; beak small and short, apparently 1-segmented; dorsally with an occasional relatively large, circular, apparently very faintly multilocular, disk pore, with much more numerous, smaller circular pores with bilocular centers, scattered uniformly over the surface, and with considerably smaller, simple pores, probably in the aggregate more numerous than the second sort, but tending to cluster into groups of four or more, with wide intervals between clusters; ventrally with multilocular disk pores beneath and around in at least three distinct arches anterior to the anal plates, these normally with eight loculi and somewhat larger than the largest dorsal pore, and with much smaller, apparently simple, circular pores with oval centers, these arranged irregularly in distinctly segmental bands across the middle portion of the abdominal segments, but more numerous and less definitely arranged towards the body margin; no dorsal setæ observed except at body margin and a scattered cluster just inside the opening of each spiracular collar; ventral setæ present, not especially numerous or conspicuous, scattered, except for some indefinite segmental rows anterior to the anal plates, and most abundant on that portion of the ventral surface behind the posterior spiracles; no submarginal tubercles, such as may be found in some genera in this subfamily; the "submarginal compound pores" of *quinquepori* not in evidence; anal plates surrounded by a heavily chitinized

collar, the usual shape of the plates, from above, half ovate, but varying quite a little according to the pressure on the plate; each plate quite deep, with about 15 to 17 scattered setæ dorsally and apically, these frequently broken off, an indeterminate number, apparently three, of ventral ridge setæ, two fringe setæ placed close together at center of fold in membrane, and three to five hypopygial setæ along middle of membrane beneath fringe setæ; anal ring small, oval, with ten small setæ and some large pores.

Larva.—Stout oval, flat, average length 821μ, average width 571μ; antennæ slender, elongate, 6-segmented, the third very long; legs slender, claw without denticle, digitules slender, those of claw slightly knobbed, those of tarsus hair-like; spiracular spines occuring singly, stout, somewhat tapering; on abdomen, at least, with two dorsal rows of minute pores on each side of the body; ventrally with a submarginal row of relatively long hairs and a similar parallel row some distance in from the margin: anal plates elongate, each with a long apical seta, two small subapical setæ and a subbasal seta; with one pair of fringe setæ.

This species has been described from the following lots of specimens: In branches of *Inga laurina*, Mayaguez, Porto Rico, March, 1915, collected by R. H. Van Zwaluwenburg (holotype and paratypes); on "guama", San-Juan, P. R., Nov. 1912, collected by W. V. Tower (paratypes); beneath bark of *Hematoxylon campechianum* (logwood), Botanic Garden, St. George, Grenada, Nov. 13, 1918 (A-971) and Nov. 19, 1918 (A-1021), Friendship Estate, Tobago Island, Nov. 7, 1918 (A-912), and on the Savanna, Port-of-Spain, Trinidad, Nov. 23, 1918, all collected by Harold Morrison (paratypes), and in the cavities of the stems of *Triplaris surinamensis* Chanc. with *Pseudomyrma* sp. nov. (allied to *Ps. triplaridis* Forel), collected by Dr. W. M. Wheeler at Camaria, British Guiana (paratypes). In all instances where information is available, the species is reported as receiving the attention of some species of ant.

The types are in the U. S. National Collection of Coccidæ.

Aside from the very obvious difference in the presence or absence of the "submarginal compound pores," the two preceding species may be separated very easily by a comparison of a number of other structural characters, as the shape and size of the marginal setæ, the distribution of the ventral disk pores, the character of the dorsal pores in the adult female, and the conspicuous difference in the lengths of the submarginal setæ in the larvæ.

Under the name *Pseudophilippia iniquilina*, Prof. Newstead has described[3] from Jamaica a coccid which quite obviously has little or no relationship with the genotype of *Pseudophillipa*, and equally obviously is closely related to the two preceding species. So far as can be ascertained from the figures and the somewhat incomplete description of this species, it stands in an intermediate position between *quinquepori* and *secretus*.

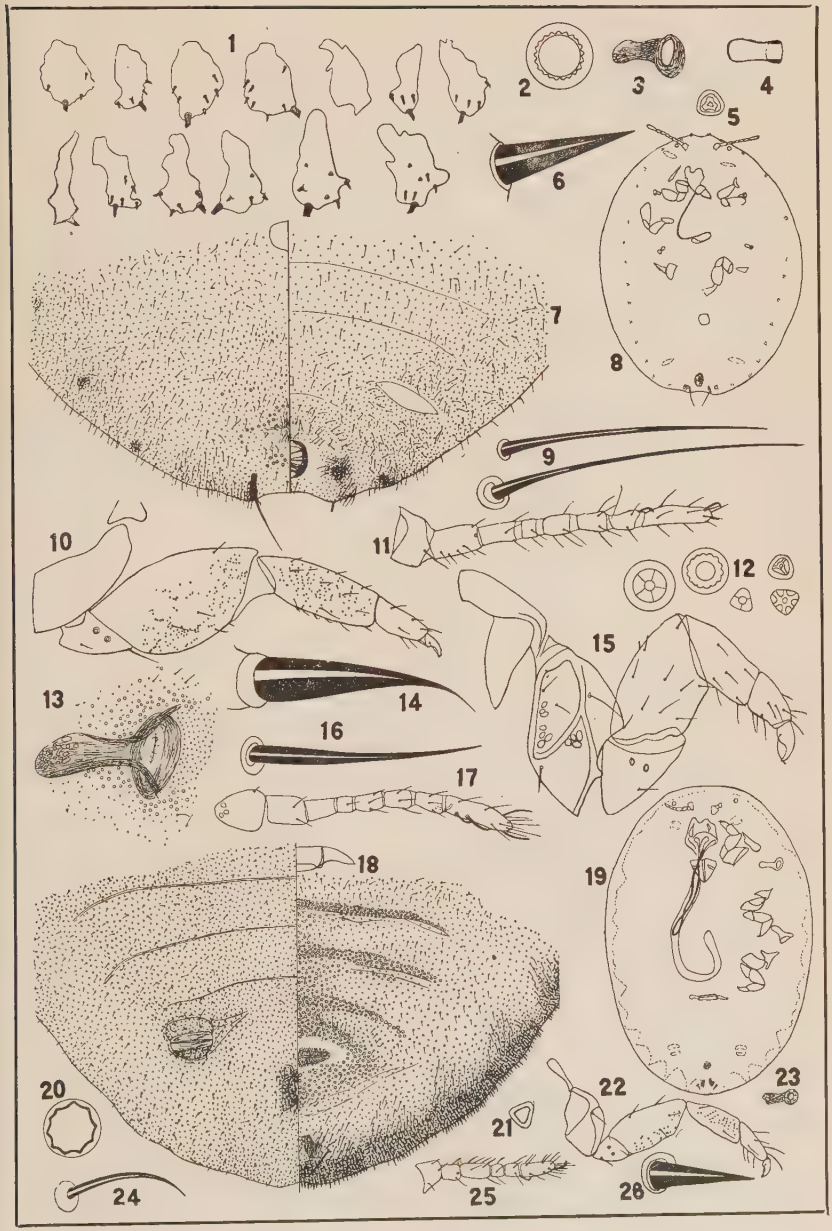
Explanation of Plates.

Plate V.

Fig. 1. *Pseudococcus bromeliæ* (Bouché). Variation in shape of ventral chitinized area of anal lobes, all XI53; top, from left to right, from pineapple, Georgetown, British Guiana (H. Morrison, No. A-703) (2); from Kartabo, B. G. (Wheeler No. 209); from Kartabo, B. G., in leaf petioles of *Tachigalia paniculata* (Wheeler No. 247)(2); from Kartabo, B. G. in stem swellings of Cordia nodosa (Wheeler No. 367) (2); bottom, from left to right, first two same as last two of top row; remainder from Kartabo, B. G. in stems of red Cecropia (Wheeler No. 116).

Fig. 2-11, *Pseudococcus rotundus*, new species, all adult female. Fig. 2, ventral disk pore, XI000; Fig. 3, spiracle, X80; Fig. 4, tubular duct, XI000; Fig. 5. triangular pore, XI000; Fig. 6, cerarian spine, XI000; Fig. 7. apex of abdomen, X40; Fig. 8. outline from below showing position of parts, XII. 6;

[3]Bull. Ent. Research, vol. X, 1920, p. 181, fig. 5.



MORRISON:—COCCIDAE

Fig. 9. dorsal (above) and ventral (below) setæ, XI000; Fig. 10. posterior leg, X80; Fig. 11. antenna, X80.

Fig. 12-19, *Farinococcus multispinosus*, gen. et sp. nov., all adult female. Fig. 12. spiracular, multilocular disk and triangular (three views) body pores, XI000; Fig. 13. anterior spiracle, X80; Fig. 14. cerarian spine, XI000; Fig. 15. posterior leg, X-80; Fig. 16. body seta, XI000; Fig. 17. antenna, X80; Fig. 18. apex of abdomen, X40; Fig. 19. outline of body from below, showing location of parts, extent of spine and seta clusters shown by dotted line at margin, X8;

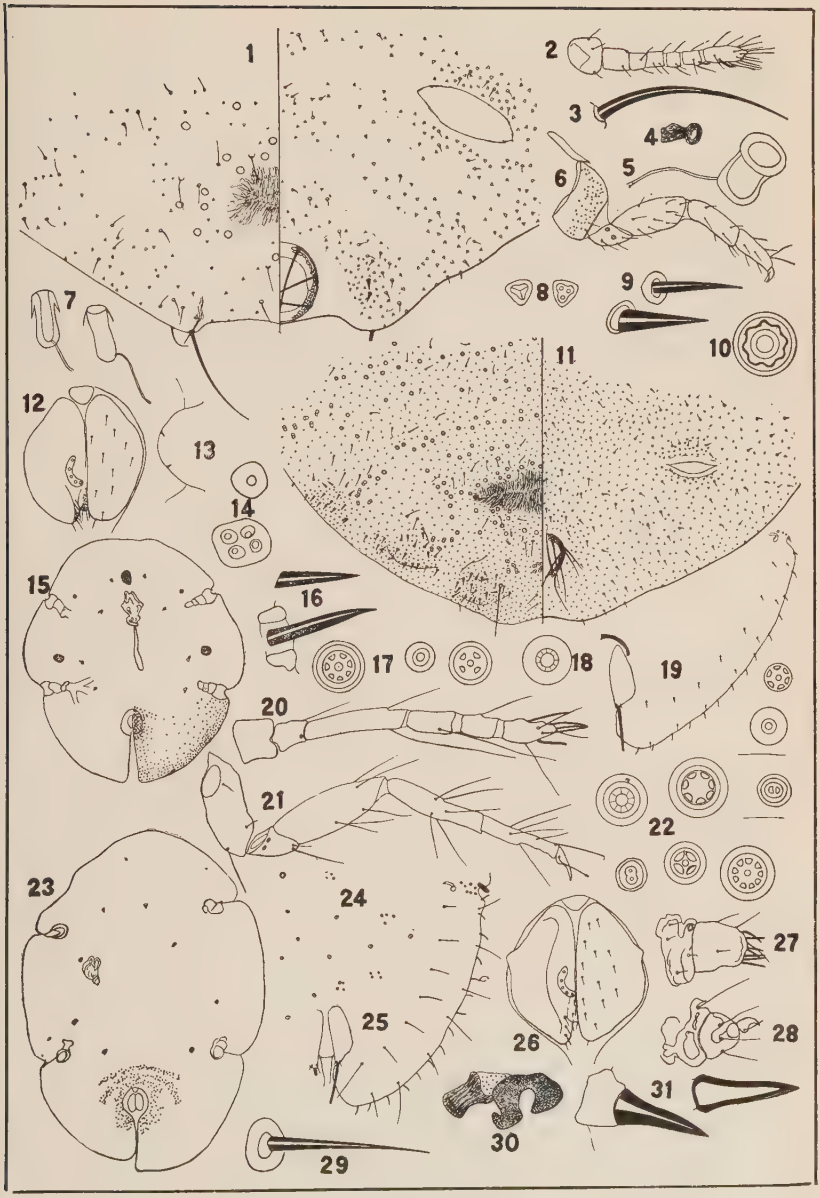
Fig. 20-26, *Ripersia petiolicola*, sp. nov., all adult female. Fig. 20. ventral multilocular disk pore, XI000; Fig. 21. triangular pore, XI000; Fig. 22. posterior leg, X80; Fig. 23. spiracle, X80; Fig. 24. ventral seta, XI000; Fig. 25. antenna X80; Fig. 26. cerarian spine XI000.

Plate VI.

Fig. 1. *Ripersia petiolicola*, sp. nov., adult female, apex of abdomen, XI53.

Fig. 2-11. *Ripersia subcorticis*, new species, all adult female. Fig. 2. antenna, X80; Fig. 3. ventral seta, XI000; Fig. 4. spiracle, X80; Fig. 5. larve ventral tubular duct, XI000; Fig. 6. posterior leg, X80; Fig. 7. small ventral tubular ducts, XI000; Fig. 8. triangular pore, XI000; Fig. 9. dorsal seta (above) and cerarian spine (below), XI000; Fig. 10. ventral multilocular disk pore, XI000; Fig. 11. apex of abdomen, X80.

Fig. 12-19, *Akermes quinquepori* Newst., all adult female except last. Fig. 12. anal plates, X80; Fig. 13. margin of spiracular thickening showing spines, X80; Fig. 14. dorsal simple pores, singly and in cluster, XI000; Fig. 15. outline of body, optical section, showing particularly the five dorsal "cribriform plates" and the arrangement of the ventral disk pores, X8; Fig. 16. marginal spines XI000; Fig. 17. ventral multilocular disk and simple pores, XI000; Fig. 18. Dorsal multilocular disk pore, XI000; Fig. 19. margin of abdomen of larva showing short ventral setæ, X80.



MORRISON:—COCCIDAE

Fig. 20-31. *Akermes secretus*, sp. nov., all adult female except first two and figure twenty-five. Fig. 20, antenna of larva, XI53; Fig. 21. leg of larva, X153; Fig. 22. adult female, group of derm pore sorts, XI000; Fig. 23. outline in optical section, showing parts, and arrangement of ventral multilocular disk pores, X8: Fig. 24. section of dorsal derm in abdominal region, showing tendency of small simple pores to group in clusters of four, X40; Fig. 25. larva, margin of abdomen showing long slender ventral setæ, X80; Fig. 26. adult female, anal plates, X80; Fig. 27. antenna, X153; Fig. 28. legs XI53; Fig. 29. ventral seta, XI000; Fig. 30. spiracle, X40; Fig. 31. marginal spines, XI000.

CONOAXIMA, A NEW GENUS OF THE HYMENOPTEROUS FAMILY EURYTOMIDÆ, WITH A DESCRIPTION OF ITS LARVA AND PUPA.

By Charles T. Brues[1]

During the course of his investigations on myrmecophilous plants in British Guiana, Professor I. W. Bailey obtained specimens of a remarkable Hymenopterous insect parasitic on ant-queens.

The following notes on its habits have been furnished by Professor Bailey.

"The colonies of *Azteca constructor* Emery and of *A. alfaroi* Emery which inhabit the fistulose stems of *Cecropia angulata* I. W. Bailey, the common myrmecophytic Cecropia of the Kartabo Region of British Guiana, are initiated by young fecundated queens in juvenile plants. The queens enter the internodal chambers through circular perforations cut in groove-like depressions (Prostomata) in the sides of the stem. These entrance apertures are covered with triturated pith on their central sides and ultimately become occluded by callus, which seals the queens within the 'primordial chambers.'

"Although many of the successive internodal cavities of each young plant become inhabited, few of the queens succeed in raising a brood. When the stems are cut open, most of the chambers are found to contain dead queens. I was unable to account for this high mortality until I discovered the presence of a small scar in the callus which fills the entrance aperture. This scar within a scar indicated, of course, that some insect had emerged since the queen became sealed within her domatium. Following up this clue, I soon found chambers—with modified callus in the apertures—which contained, in addition to the dead and frequently dismembered queen, the larva, pupa or imago of a Hymenopterous parasite. The evidence at hand seems to indicate that the queens are parasitized before they enter their dwellings."

[1]Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 209.

The parasite proves to represent an undescribed genus which may be characterized as follows:

Conoaxima gen. nov.

Similar to Axima Walker. Head strongly transverse, deeply emarginate behind, with an erect spine or tooth in front of each lateral ocellus, cheeks and temples separated from head behind by a strong ridge or carina; ocelli in a curved line, the lateral one close to the eye; antennæ inserted at the middle of the face, 11-jointed, with one ring-joint; front with a deep groove that receives the two antennal scapes; eyes oval, bare, one-third longer than the malar space; anterior orbits divergent below, the head in front not conspicuously narrowed toward the mouth; temples rounded behind the eyes. Pronotum as long as the mesonotum, with a strong, tooth-like or sharply rounded projection medially in front; scapulæ separated behind by half the length of the mesonotum. Scutellum conical, twice as long as the mesonotum, its tip extending well over the propodeum. Abdomen long, compressed, petiole about half the length of the hind femur; fifth segment the longest; sixth and seventh also much lengthened, stigmal and postmarginal veins of equal length, each half as long as the marginal. Head and thorax deeply, coarsely punctate; black.

Type species: *C. aztecicida* sp. nov.

This genus is very similar to Axima, but differs in several important characters. The scutellum is conical in form, not rounded, the abdominal petiole is very much shorter and the marginal vein only about twice as long as the stigmal. The spines on the vertex in the two genera are similar, but there is no ridge between them in Conoaxima. The large conical scutellum which projects over the propodeum, with its upper surface in the same plane as the mesonotum give the insect the appearance of an Eucharid.

In addition to the species taken by Professor Bailey in British Guiana, I have a second one obtained by Professor W. M. Wheeler some years ago at Quirigua, Quatemala, also from a

nest of Azteca. Without doubt, the Central American species is also a parasite of these ants.

The two species may be distinguished as follows:

Frontal projections spiniform, acute, much longer than broad at base; median projection of pronotum acute; scape of antennæ black or piceous; .....*C. aztecidida* sp. nov.

Frontal projections triangular, as high as broad at base; median projection of pronotum rounded; scape of antennæ more or less ferruginous, especially toward base ..*C. affinis* sp. nov.

Conoaxima aztecicida sp. nov.

♀. Length 4.2 mm. Black; abdomen obscurely stained with rufous at the sides of the sixth and base of the seventh segment; antennal scape entirely, pedicel, except above; knees, tibiæ and tarsi of front legs; knees and apices of tibiæ of four posterior legs, yellow; middle and hind tarsi, except tips, white. Body clothed with white, bristly hairs, one arising from each puncture on the thoracic nota, with a denser patch on the metanotum and hind coxa below; tip of abdomen also white haired; legs clothed with white hairs which form quite a distinct fringe on the hind femora beneath. Head closely and densely punctate, each puncture about half as wide as the diameter of the scape and almost everywhere so close together that the space between them forms an irregularly hexagonal reticulum. Lateral ocelli much closer to the eye than to the median ocellus, the lateral ones oval, separated by their own width from the eye; frontal spine just in front and slightly toward the median line from the lateral ocellus; head seen from above two and one half times as broad as thick, with the eyes extending almost to the front and to the temples. Antennal scape extending to the median ocellus, less than half as long as the flagellum; pedicel narrower than, and only half as long as the first funicular joint; one ring-joint; the five funicle joints growing thicker and slightly shorter, first one oval, twice as long as thick, fifth but little longer than thick; club composed of three distinct joints, as long as the two preceding funicular joints together, entire

flagellum clothed with long, sparse white hairs. Pronotum one-third as long as wide, very slightly and broadly emarginate medially behind; punctation like that of the head, forming about seven irregular transverse rows; mesonotum and scutellum sculptured like the pronotum; scapulæ less clearly separated behind where they are separated by about one-fourth the width of the thorax; a very deep transverse impression between the median lobe of mesonotum and the scutellum; the latter sharply upturned at the tip, and with a broad shallow shagreened impression basally at the sides, the centre of the impression with a tuft of white hairs. Propodeum with a large shield-shaped shagreened areola extending from base to apex and a lateral transversely reticulate areola on each side, the carinæ very strong. Pleuræ opaque, almost entirely without large punctures except on the densely hairy metapleuræ; mesopleura with a few oblique lines. Hind coxæ granulate, densely hairy externally. Petiole with a median furrow above and an incomplete lateral one; second to fourth segments short, subequal, together distinctly shorter than the fifth, which is by far the longest segment, sixth and seventh of about equal length, each on the dorsum two-thirds as long as the fifth, the sixth with a small round, very distinct spiracle near the base, the seventh with a larger one toward tip; eighth barely extruded; gaster in profile lanceolate, one-third as high as long, highest at the base of the fifth segment. Wings hyaline, venation pale; rather densely hairy, but without noticeably marginal fringe; hind wing with three frenulum hooks.

Type from Kartabo, British Guiana (I. W. Bailey, collected as described on a previous page of this journal (Psyche, vol. 29, p. 153.

Conoaxima affinis sp. nov.

♀. Length 3.7 mm. Very similar to *C. aztecicida*, but differing most distinctly as indicated in the table above. The thorax is also more coarsely punctate, especially the scutellum where about eight punctures form a longitudinal line.

Type from Quirigua, Guatemala, January 14, 1912. (W. M. Wheeler). This species undoubtedly attacks Azteca also, as Professor Wheeler took the specimen from the hollow thorn of an Acacia when collecting nests of Azteca at a place where these ants were abundant.

The anatomical similarities between Conoaxima and Axima are interesting on account of the habits of the two genera. The first account of the habits of Axima was given by Howard[1] who cites a number of instances in which *Axima zabriskei* Howard has been reared from small bees under conditions that allow of little doubt that the Axima is a primary parasite. On three occasions the Rev. J. L. Zabriskie bred examples from nests of *Ceratina dupla* in stems of sumac at different localities in New York State. Howard found also in the Museum of Comparative Zoölogy at Cambridge specimens presumably bred by Mr. H. G. Hubbard from larvæ found in burrows of a small blue bee at Fresh Pond in Cambridge, and further specimens in the Cornell University collection bred from a bee supposed to be *Ceratina dupla*. There can be no doubt therefore, that *A. zabriskei* attacks Ceratina and it is very probable that the other members of the genus parasitize small bees of some kind.

Professor Bailey obtained also a single larva and pupa of Conoaxima. The larva probably full-grown is of quite unique form, due to the presence of a dorsal series of large, unpaired tubercles. The first of these is on the metathorax and each of the four following segments bears another one; those of the abdomen are larger than the metathoracic one and of about equal size. From the wrinkled appearance of the thin integument that covers the tubercles, it seems evident they are capable of considerable distension during life. After preservation in alcohol, the larger tubercles project for a distance of about one fourth the dorso-ventral thickness of the body and are more than half the width of the body segments to which they are attached. Following these there is a much smaller projection at the tip of the sixth segment and a minute one at the tip of the seventh. From the position of the head and the curvature

[1]Insect Life, vol. 2, pp. 365-367, 3 figs. "A North American Axima and its Habits" (1890)

of the body it is clearly evident that these appendages are dorsal and not ventral as one might naturally suppose from analogy with other insect larvæ. Laterally nine small circular spiracles form a continuous series from the mesothorax to the seventh abdominal segment. Scattered over the body are a number of very minute spiniform black tubercles from the apex of some of which there projects a hyaline seta. Most likely all the spines bear setæ in perfect specimens; they are arranged as follows: prothorax with a transverse ring of twelve; meso and metathorax with a ring of ten, interrupted above; first abdominal segment with one above the spiracle and a series of three below; second to sixth with one above and two below; seventh and eighth with only two on each side although the eighth bears several other round chitinized dots; apical segment with a ring of about ten. In addition the head bears a seta, without tubercle, at each side of the front and one on each cheek.

The pupa is similar in general form to the imago and the body, including the head, bears a few scattered long bristly hairs. It is nowhere noticeably tuberculate except that behind each antenna there is a lanceolate projection that represents in exaggerated form the carina behind the eye of the adult. Above, the head is bilobed, due to a deep median impression, but the surface of each lobe is evenly convex and shows no trace of the spiniform processes of the imago. The anterior margin of the pronotum has a median tubercle which is crowned at apex with a tuft of sparse, short bristly hairs. This no doubt is a functional pupal organ, the vestige of which persists in the imago as the median pronotal projection or tooth described on a previous page. Seven pairs of abdominal spiracles are visible, each deeply pigmented, entering the tracheal trunks by more weakly pigmented funnels.

So far as I can ascertain, the only reference to any larva similar to the one just described, relates to Axima which is said by Howard (*loc. cit.*) to have "six or more strong dorsal tubercles." According to the same author the pupa of Axima has the head strongly tuberculate which is not the case in Conoaxima, except for the lamelliform projections on the temples.

SYNOPSIS OF PANURGIDÆ (*HYMENOPTERA*).

By Charles Robertson.

Carlinville, Illinois.

My synopses of local bees are intended to show how I distinguish them. It is assumed that the student has only the local species and all of them. Nothing follows from such a statement as that *Chloralictus nymphalis* runs to *C. testaceus* in my table of Halictinæ. If it had been one of the local species, it would not have run to that name.

The differences between the Panurgidæ and Dufoureidæ are partly mentioned in the "Synopsis of Anthophila", Can. Ent. *36*: 42, 1904. The local species mix the pollen with honey, but *Panurgus* evidently does not. It has a large scopa which is not necessary in those which stick the pollen with honey.

Often the two cubital cells are not homologous, so that the bees are referred here on account of other resemblances. In Perditinæ the cubital cells are the first and third, the second being obliterated by coalescence of the first and second transverse cubital nervures. The "first transverse cubital" is a compound vein, and the "second" is really the third. Usually in the rest of the Panurgidæ the true second transverse cubital vein is wanting and the one called "second" is the third. The "second cubital cell" is composed of the second and the third united. I have a specimen of *Pseudopanurgus compositarum* with three cubital cells. In true *Panurginus* I think the first and second cubital cells are united and that the venation is not homologous with that of American species which have been referred to that genus. I have seen *P. albopilosus* and *montanus*, determined by Friese. These have an independent origin from forms having three cubital cells.

Abbreviations.—1p 1 = basal joint of labial palp; 1p 4:2 = length of first and second joints as 4 to 2; Ma, Mas = long-tongued bee flowers; Mi, Mis = short-tongued bee flowers; mp 6 = maxillary palps six-jointed; oligolege = bee collecting pollen

from related flowers; Pol = polytropic flowers, adapted to various short-tongued insects; R = Red, all dark colors; social flowers = flowers crowded so that insects pass from one to another without taking wing or climbing; W = white; Y = yellow, greenish to orange,

Females.

1. Marginal cell about as long as stigma; cubital cell 1 about twice as long as 2; recurrent veins about opposite transverse cubitals; discoidal part of basal vein about twice as long as cubital part; lower border of discoidal cell 3 shorter than that of 1; middle spur about half as long as planta; face with colored marks; scopa simple, pollen on front of tibia; glossa linear; 1p 1 flat, longer than 2-4; head and thorax greenish, abdomen black or brown, **Perditinae.**
2. Marginal cell longer than stigma; cubital cells usually subequal; recurrent vein 1 beyond transverse cubital 1, 2 usually before 2; discoidal part of basal vein more than twice as long as cubital part; middle spur more than half as long as planta; mp 6; black, 3.
3. Stigma middle-sized; recurrent veins about equally distant from transverse cubitals; face with yellowish marks; scopa simple, pollen mainly on front of tibia but also around planta; glossa filiform; 1p 1 flat, at least longer than 2-4, **Calliopsinae.**

a. Stigma large; recurrent vein 1 usually remote from transverse cubital 1, 2 near or opposite 2; lower border of discoidal cell 3 shorter than that of 1; face without marks; pollen on front of tibia, **Anthemurginae.**

Males.

4. Venation as in 1 **Perditinae.**
   Venation as in 2, mp 6 5.
5. Venation as in 3, **Calliopsinae.**
   Venation as in 3a **Anthemurginae.**

PERDITINÆ

Females.

Claws simple; clypeus, interrupted basal fasciæ on segments 2-3, wings and veins, whitish; border of stigma and of marginal cell fuscous; mp 6, short; 1p 5: 1; 4mm; oligolege of *Boltonia asteroides*; Sept. 3; *boltoniæ* in, **Perditella.**

Claws with an inner tooth, 1.

1. Veins fuscous; claw tooth subapical; five marks on face, base of mandibles, two spots on collar, tubercles, anterior tibiæ in front, middle knees, and oblique basal fasciæ on sides of segments 1-4, whitish; mp 6, long; 1p 6: 1; 6-7mm; oligolege of Astereæ and Heliantheæ; Aug. 17-Sept. 20; *octomaculata* in **Perdita.**

Veins black; claw tooth median; mandibles, anterior tibiæ in front, and tarsi, yellowish; usually a dot on each side of segment 3, and often on 4; middle tibiæ more or less yellowish; mesonotum purplish; metathorax bluish; mp short, joints indistinct; 1p 9: 2; 5-7mm; oligolege of *Physalis*; July 7-Sept. 3; *maura* in, **Zaperdita.**

Males.

Cheek with a distinct process; subdiscoidal and recurrent vein 2 obsolete; mandibles, clypeus, anterior tibiæ in front, middle knees and tarsi, whitish; 4-5mm; Aug. 30-Sept. 8;*boltoniæ* in, **Perditella.**

Cheek simple; veins ordinary; at least the mandibles, labrum, clypeus, sides of face, scape, flagellum beneath, anterior and middle tibiæ in front, front and middle tarsi, and hind knees, yellow 1.

1. Face of about equal width below; cheeks narrow; coxæ trochanters, anterior and middle femora and tibiæ in front, and spots on segments 1-4, yellow; hind tarsi dark; 5-6mm; Aug. 13-Sept. 24; *octomaculata* in, **Perdita.**

Face broader below; cheeks broad; coxæ, trochanters, femora except tips, and abdomen, black; front and middle tibiæ almost entirely yellow; posterior orbits yellow below; hind tarsi yellow; 5mm; July 17-Aug. 1; *maura* in, **Zaperdita.**

CALLIOPSINÆ

Females.

Front tarsi simple; disc of metathorax short, rugose; abdomen finely punctured, rather opaque; veins dark; cubital cell 2 narrowed about one-half above; ornaments luteous, at least the clypeus in part, spot above, sides of face, two lines on collar, and front and middle knees; flagellum testaceous beneath; 1p 7: 1, **Calliopsis.**

Front tarsi with curled spines; disc of metathorax smooth, shining, foveate; abdomen sparsely punctured, shining; wings hyaline, veins pale; cubital cell 2 narrowed less than one-half above; apex of labrum and of clypeus, triangular mark on each side of face, base of mandibles, and front knees, whitish; mp and galea 5: 14; 1p 13: 1; 7-8mm; oligolege of *Verbena*; June 28-Sept. 10; *verbenæ* in **Verbenapsis.**

Males.

Disc of metathorax shining, foveate; wings hyaline, veins pale; cubital cell 2 narrowed less than one-half above; front tarsi pale, with long hair; base of mandibles, middle ½ of labrum, sides of face, clypeus except sides of base, front and middle knees, and line on front tibia, whitish; 6-7mm; July 2-Sept. 1; *verbenæ* in, **Verbenapsis.**

Disc of metathorax opaque, rugose; wings a little dusky, veins dark; cubital cell 2 narrowed about one-half above; front tarsi with short hair; at least the mandibles, labrum, face below antennæ, two lines on collar, tarsi, and tibiæ in front, yellow, **Calliopsis.**

CALLIOPSIS

Females.

Clypeus black, with a median stripe, 3 spots above; lateral face marks subquadrate, not extending above antennæ; spot on tubercles; rarely a dot on tegulæ; labrum dark; mp and galea subequal; 6-8mm; polylege; May 30-Oct. 14, **andreniformis.**

Clypeus luteous, with two black stripes, 1 spot above; lateral face marks pointed above antennæ; tubercles black; dot on tegulæ; mp shorter than galea; 7mm; oligolege of Heliantheæ and Astereæ; Aug. 20-Sept. 19, **coloradensis.**

Males.

Tubercles, legs, antennæ except flagellum at base above, yellow; tegulæ usually dark; 5-6mm; May 30-Sept. 19 **andreniformis.**

Tubercles, coxæ, trochanters, femora except tips, tibiæ behind, and apical joints of tarsi more or less, black; dot on tegulæ; line on scape in front; flagellum testaceous beneath; 6-7mm; Aug.21—Sept. 24, **coloradensis.**

ANTHEMURGINÆ.

Females.

Scopa plumose; glossa linear, acuminate; 1p 1 elongate, flat; mp not longer than galea; tegulæ and front and middle knees testaceous, **Pseudopanurgus.**

Scopa simple; mp longer than galea, 1.

1. Lp 4: 1½, 1 flat; glossa lance-linear, acuminate; nearly bare, finely and densely punctured, opaque; middle spur sparsely pectinate, about as long as planta; tegulæ and front and middle knees testaceous; 5-6mm; polylege; May 28—Oct. 23; *parvus* in, **Heterosarus.**

Lp 2:2, 1 simple, incrassate; glossa lanceolate, shorter than mentum; middle spur finely pectinate, two-thirds as long as planta; finely punctured, shining, head more coarsely punctured and opaque; knees black; apical half of wings clouded; 7-8mm; oligolege of *Passiflora lutea*; July 21—Sept. 9; *passiflorœ* in **Anthemurgus.**

Males.

Clypeus and sides of face with yellow stripes; black, mandibles, tarsi, anterior tibiæ in front, and sometimes middle ones, testaceous; apical half of wings clouded; 7-8mm; July 21—Aug. 30; *passiflorœ* in **Anthemurgus.**

Clypeus entirely and sides of face yellowish or whitish, 1.

1. Lateral face marks hardly extending above clypeus; mandibles, middle of labrum, clypeus and face marks, whitish; flagellum beneath, tubercles, tegulæ, knees, tarsi, and anterior tibiæ in front, testaceous; 5-6mm; May 28—June 15; *parvus* in **Heterosarus.**

Lateral face marks extending above clypeus; at least the clypeus, sides of face, tarsi, anterior tibiæ in front, and bases of middle and hind tibiæ, yellow, **Pseudopanurgus.**

PSEUDOPANURGUS

Females.

Mesonotum rugose, with coarse confluent punctures; enclosure of labrum subquadrate; a supraorbital tubercle; wings clouded beyond middle; recurrent vein 1 remote from transverse cubital 1, 2 near transverse cubital 2; mp shorter than galea; lp 10: 2; 7-8mm; oligolege of Helianthemæ; Aug. 2—Oct. 1, **rugosus.**

Mesonotum more finely punctured, 1.

1. Enclosure of labrum subquadrate, 3.

Enclosure of labrum rugose, strongly narrowed apically; middle of flagellum beneath testaceous; mp a little shorter than galea, 2.

2. Metathorax shining, impunctate; tubercles yellow: head and mesonotum more sparsely punctured; veins darker; 1p 7: 2; 6-7mm; oligolege of Heliantheæ; Aug. 3—Sept. 28, **labrosus.**

   Metathorax opaque, punctate behind; tubercles dark; head and mesonotum more closely and coarsely punctured; veins paler; 1p 6½: 3; 5-6mm; oligolege of Heliantheæ; Aug. 15—Sept. 25 **labrosiformis.**

3. Hind tarsi not yellow; 6-7mm, 5.

   Hind tarsi yellow; mp shorter than galea 4.

4. Scutel shining, almost impunctate; mesonotum not trisulcate; enclosure of labrum more narrowed apically; wing clear hyaline; veins pale; scopa with long, long-barbed hairs; 1p 8: 3; 6-7mm; oligolege of Heliantheæ; May 29—Sept. 5, **albitarsis.**

   Scutel more opaque, closely punctured; mesonotum trisulcate; enclosure of labrum less narrowed apically; wing less hyaline; scopa with short, short-barbed hairs; 1p 7: 3; 5-7mm; oligolege of Astereæ and Heliantheæ; Aug. 11—Oct. 4, **solidaginis.**

5. Mesonotum nearly bare; shining, rather finely and closely punctured; scopa rather short; mp about equaling galea; 1p 4: 1; oligolege of Astereæ and Heliantheæ; Aug.23—Oct. 23 **asteris.**

   Mesonotum distinctly pubescent, 6.

6. Mesonotum entirely pubescent, opaque, with large shallow dense punctures; scopa rather short; mp about equaling galea; 1p 4: 1½; oligolege of Astereæ; Sept. 6—Oct. 29, **compositarum.**

   Mesonotum pubescent in front, shining, minutely and sparsely punctured; scopa long and thin; mp a little shorter than galea; 1p 4½:2; oligolege of Heliantheæ; Aug. 1—Sept. 12, **rudbeckiae.**

Males.

Mandibles and labrum yellow, 2.

Mandibles and labrum black; apical joints of tarsi blackish; 6-7mm 1.

1. Mesonotum coarsely reticulated; wings clouded beyond middle; broad bases of middle and hind tibiæ yellow; July 29—Aug. 22, **rugosus.**

Mesonotum shining, sparsely punctured; wings hyaline; middle and hind knees yellow; June 11—Sept. 8, **albitarsis.**

2. Enclosure of labrum slightly narrowed towards apex, 4.

Enclosure of labrum strongly narrowed and subbidentate at apex; middle joints of flagellum fulvous beneath, 3.

3. Metathorax shining, impunctate; tubercles yellow; hind tibiæ broadly yellow at base; 5-6mm; Aug. 1-30 **labrosus.**

Metathorax punctured behind; tubercles black; hind knees yellow; 4-5mm; Aug. 3—Sept. 8, **labrosiformis.**

4. Middle of clypeus concave, impunctate; tubercles and middle and hind knees yellow; 5-7mm; Aug. 3—Sept.7, **rudbeckiae.**

Middle of clypeus convex, punctate, 5.

5. Mesonotum opaque, with large dense shallow punctures, closely pubescent; antennæ long; face below antennæ, and tibiæ, except spot beneath, yellow; 5-6mm; Aug—28—Oct. 4, **compositarum.**

Mesonotum more shining, the pubescence short or sparse, 6.

6. Hind tibiæ yellow at least on basal third; tubercles yellow; mesonotum finely punctured, not trisulcate; 5-6mm; Aug. 23—Oct. 21, **asteris.**

Hind tibiæ yellow at extreme base; tubercles black; mesonotum coarsely punctured, trisulcate; 4-6mm; Aug. 12—Sept. 7, **solidaginis.**

PHENOLOGY.—Of the dominant families of bees the Panurgidæ have the most definite phenological position. They fly from May 28 to October 29, all of them together August 30—September 3.

Phenologically the sexes begin and end as follows:

Begin			End		
♂ first	♂ ♀ together	♀ first	♀ last	♂ ♀ together	♂ last
37.5	25.0	37.5	75.0	....	25.0

The males which are first precede by 6.1 days and the females which are last are later by 29.2 days. It is probable that all of the species are proterandrous, but the males precede by so few days and are so much harder to observe that it is not easy to prove the proterandry. My dates give the earliest ever observed and it is probable that, in the year in which the earliest date for the female was recorded, the male really preceded. The records show 124 flower visits for the females and 92 for the males, which indicates how much more likely the flight of the female is to be correctly made out.

Taking the cases in which the males were first and the females last as normal examples we have for the average number of days:

	♂ precedes	♀ follows	♂	♀	Species
4 normal	7.2	27.5	32.5	52.7	59.5
12 others	....	....	46.0	66.3	68.6
Total	....	....	42.6	62.9	66.3

The oligoleges are 85.5 per cent. of the species. They average 55.3 days, while the two polyleges average 143.5 days.

FLOWER VISITS.—In the following lists the pollen visits of the female (♀c) are separated from the nectar visits (♀s). The pollen visits do not exclude nectar visits to the same flowers. Visits of the male (♂s) not made by the female also are in italics. Visits to Compositæ are distributed under Anthemideæ, Astereæ, Eupatorieæ, and Heliantheæ.

ANTHEMURGUS PASSIFLORÆ.— ♀ c (1): *Passifloraceæ*: Passiflora, type July 31.

♂ s (1): *Passifloraceæ*: Passiflora lutea, *type* July 31.

CALLIOPSIS ANDRENIFORMIS (51).— ♀ c (19): *Asteræ*: Aster ericoides villosus; *Heliantheæ*: Verbesina helianthoides; *Labiatæ*: Lycopus sinuatus, Pycnanthemum pilosum; *Leguminosæ*: Desmodium marilandicum, D. paniculatum, Melilotus alba, Psoralea onobrychis, Trifolium repens, T. pratense; *Lythraceæ*: Lythrum alatum; *Malvaceæ*: Malva rotundifolia; *Oxalidaceæ*: Oxalis stricta; *Polygalaceæ*: Polygala sanguinea; *Rubiaceæ*: Houstonia purpurea; *Scrophulariaceæ*: Gerardia tenuifolia; *Verbenaceæ*: Lippia lanceolata, Verbena hastata, V. urticifolia.

♀ s (23): *Acanthaceæ*: Dianthera americana; *Heliantheæ*: Bidens aristosa, Coreopsis palmata; *Labiatæ*: Blephilia ciliata, Hedeoma pulegioides, Nepeta cataria, Prunella vulgaris, Pycnanthemum flexuosum, P. virginianum; *Leguminosæ*: Amorpha canescens, Lespedeza procumbens, L. reticulata, Strophostyles pauciflora, Stylosanthes biflora, Trifolium hybridum; *Lythraceæ*: Ammannia coccinea; *Orchidaceæ*: Spiranthes gracilis; *Polygonaceæ*: Polygonum pennsylvanicum; *Portulacaceæ*: Portulaca oleracea; *Scrophulariaceæ*: Ilysanthes riparia; *Umbelliferæ*: Eryngium yuccæfolium; *Verbenaceæ*: Verbena bracteosa, V. stricta.

♂ s (29:9): *Acanthaceæ*: Dianthera americana; *Anthemideæ*: *Chrysanthemum leucanthemum*; *Heliantheæ*: Coreopsis palmata, *Rudbeckia triloba*; *Labiatæ*: Blephilia ciliata, Hedeoma pulegioides, Pycnanthemum pilosum, P. virginianum, *Stachys palustris*; *Leguminosæ*: *Lespedeza capitata*, L. procumbens, L. reticulata, Melilotus alba, Psoralea onobrychis, Trifolium hybridum, T. repens; *Malvaceæ*: Malva rotundifolia; *Polygonaceæ*: Polygonum pennsylvanicum; *Polygalaceæ*: Polygala sanguinea; *Rhamnaceæ*: *Ceanothus americanus*; *Rosaceæ*: *Geum album*, *Gillenia stipulacea*, *Potentilla monspeliensis*; *Rubiaceæ*: Houstonia purpurea; *Scrophulariaceæ*: Gerardia tenuifolia; *Umbelliferæ*: *Cryptotænia canadensis*, Eryngium yuccæfolium; *Verbenaceæ*: Lippia lanceolata, Verbena urticifolia.

♂ ♀ in copula (1): Psoralea onobrychis, June 26; several other cases not recorded.

CALLIOPSIS COLORADENSIS (5).— ♀ c (5): *Astereæ* Boltonia asteroides, Solidago canadensis; *Heliantheæ*: Bidens aristosa, Coreopsis tripteris, Rudbeckia triloba.

♂ s (4)*Astereæ*: Boltonia asteroides, Solidago canadensis; *Heliantheæ*: Bidens aristosa, Rudbeckia triloba.

♂ ♀ in copula (7): Bidens aristosa, Aug. 31; Boltonia asteroides, Aug. 29, Sept 1; 12, two pairs; Solidago canadensis, Aug. 23, Sept. 12.

HETEROSARUS PARVUS (8).— ♀ c (7): *Astereæ*: Aster ericoides villosus, Solidago canadensis, S. ulmifolia; *Geraniaceæ*: Geranium carolinianum; *Labiatæ*: Monarda bradburiana, *type* May 28; *Rosaceæ*: Gillenia stipulacea; *Umbelliferæ*: Eulophus americanus.

♀ s (1): *Umbelliferæ*: Thaspium aureum trifoliatum.

♂ s (1): *Rosaceæ*: Gillenia stipulacea.

PERDITA OCTOMACULATA (7).— ♀ c (5): *Astereæ*: Aster ericoides villosus, Boltonia asteroides, Solidago canadensis, S. ulmifolia; *Heliantheæ*: Bidens aristosa.

♀ s (1) : *Labiatæ*: Lycopus sinuatus.

♂ s (5:1): *Astereæ*: Boltonia asteroides, Solidago canadensis; *Eupatorieæ*: *Eupatorium altissimum*; *Heliantheæ*: Bidens aristosa; *Labiatæ*: Lycopus sinuatus.

♂ ♀ in copula (3): Bidens aristosa, Sept. 4; Lycopus sinuatus, Sept. 5; Solidago canadensis, Aug. 17.

PERDITELLA BOLTONIÆ (1).— ♀ c (1): *Astereæ*: Boltonia asteroides, *type* Sept. 3.

♂ s (1): *Astereæ*: Boltonia asteroides, *type* Sept. 3.

PSEUDOPANURGUS ALBITARSIS (11).— ♀ c (8); *Heliantheæ*: Brauneria pallida, B. purpurea, Helianthus divaricatus, H. mollis, Rudbeckia hirta, R. laciniata, R. subtomentosa, Verbesina helianthoides.

♀ s (2): *Heliantheæ*: Coreopsis palmata, Lepachys pinnata.

♂ s (8:1) : *Astereæ*: *Aster ericoides villosus*; *Heliantheæ*: Brauneria pallida. Coreopsis palmata, Helianthus divaricatus, H. mollis, Rudbeckia hirta, R. laciniata, Verbesina helianthoides.

♂ ♀ in copula (5) : Helianthus mollis, Aug. 23; Rudbeckia hirta, June 18; 23, two pairs; 26.

PSEUDOPANURGUS ASTERIS (8).— ♀ c (8): *Astereæ*: Aster ericoides villosus. A. lateriflorus, A. sagittifolius, Solidago canadensis, S. nemoralis, S. serotina, S. ulmifolia; *Heliantheæ*: Rudbeckia triloba.

♂ s (4): *Astereæ*: Aster ericoides villosus, A. sagittifolius, Solidago canadensis, S. ulmifolia.

♂ ♀ in copula (5): Aster ericoides villosus, Sept. 14, 1893, *type*; Sept. 14, 1896; 20; A. sagittifolius, Aug. 30; Solidago canadensis, Sept. 1.

PSEUDOPANURGUS COMPOSITARUM (12). – ♀ c (7) *Astereæ*: Aster ericoides villosus, A. lateriflorus, A. multiflorus, A. novæ angliæ, A. paniculatus, Boltonia asteroides, *type* Sept. 20, Solidago ulmifolia.

♀ s (3): *Astereæ*: Aster salicifolius, Solidago nemoralis; *Polygonaceæ*: Polygonum dumetorum.

♂ s (6:2): *Astereæ*: Aster ericoides villosus, A. lateriflorus, Boltonia asteroides, *type* Aug. 28; *Heliantheæ*; *Bidens aristosa*, *Rudbeckia triloba*; *Polygonaceæ*: Polygonum dumetorum.

PSEUDOPANURGUS LABROSIFORMIS (11). – ♀ c (7): *Heliantheæ*: Actinomeris alternifolia, Bidens aristosa, Helianthus divaricatus, H. tuberosus, Heliopsis helianthoides, Rudbeckia laciniata, R. triloba.

♀ s (2): *Heliantheæ*: Coreopsis tripteris, *type* Aug. 24, Helianthus strumosus.

♂ s (7:2): *Astereæ*: *Solidago canadensis*; *Heliantheæ*: Coreopsis tripteris, *type* Aug. 24, Helianthus divaricatus, H. tuberosus, Heliopsis helianthoides, Rudbeckia laciniata, *Silphium perfoliatum*.

Stylopized: Aug. 3.

PSEUDOPANURGUS LABROSUS (4).— ♀ c (3) : *Heliantheæ*: Helianthus divaricatus, H. tuberosus, Rudbeckia triloba.

♀ s (1): *Heliantheæ*: Rudbeckia laciniata.

♂ s (3): *Heliantheæ*: Helianthus divaricatus, H. tuberosus, Rudbeckia triloba.

♂ ♀ in copula (1): Helianthus tuberosus, Aug. 14, *type*.

Stylopized: July 3, type of Crawfordia labrosi Pierce.

PSEUDOPANURGUS RUDBECKIÆ (6).— ♀ c (5): *Heliantheæ*: Bidens aristosa, Rudbeckia hirta, R. laciniata, R. subtomentosa, R. triloba.

♂s (6:1) : *Heliantheæ*: Bidens aristosa, *Helianthus divaricatus*, Rudbeckia hirta, R. laciniata, R. subtomentosa, R. triloba.

♂ ♀ in copula (4): Rudbeckia triloba, Aug. 3, 21, three pairs, *type*.

Stylopized: Aug. 1; 3, ♂ of copulating pair; 29, type of Crawfordia rudbeckiæ Pierce.

PSEUDOPANURGUS RUGOSUS (7).— ♀ c (5): *Heliantheæ*: Bidens aristosa, Helianthus divaricatus, H. mollis, H. tuberosus, *type* Aug. 22, Rudbeckia triloba.

♀ s (1) : *Heliantheæ*: Silphium perfoliatum.

♂ s (6:1): *Heliantheæ*: Helianthus divaricatus, H. mollis, H. tuberosus, *type* Aug. 22, *Heliopsis helianthoides*, Rudbeckia triloba, Silphium perfoliatum.

PSEUDOPANURGUS SOLIDAGINIS (7).— ♀ c (4): *Astereæ*: Boltonia asteroides, Solidago canadensis, *type* Sept. 18; *Heliantheæ*: Helianthus grosseserratus, Rudbeckia subtomentosa.

♂ s (6:3): *Astereæ*: Solidago canadensis; *Heliantheæ*: *Bidens aristosa*, *Coreopsis tripteris*, Helianthus grosseserratus, *H. tuberosus*, *type* Aug. 22, Rudbeckia subtomentosa.

Stylopized: Aug. 11, 12.

VERBENAPIS VERBENÆ (3).— ♀ c (3): *Verbenaceæ*: Verbena hastata, V. stricta, V. urticifolia. The concealed

pollen is drawn from the narrow tubes by inserting the front tarsi with their curled spines.

♂ s (3): *Verbenaceæ*: Verbena hastata, V. stricta, V. urticifolia.

♂ ♀ in copula (4): Verbena stricta, July 11, 21; V. urticifolia, July 15, 17.

ZAPERDITA MAURA (2).— ♀ c (1): *Solanaceæ*: Physalis lanceolata.

♀ s (1) : *Solanaceæ*: Physalis virginiana.

♂ s (2) : *Solanaceæ*: Physalis lanceolata, P. virginiana.

PAIRING HABITS.—Both sexes of all of the species were found. Thirty pairs belonging to eight species were taken in copula. The differences are remarkable. Of eight species no pairs were seen together, while of *Calliopsis coloradensis*, which flies only 36 days and visits only five flowers, seven pairs were taken together, forming a majority of the specimens.

VISITS TO FLOWER CLASSES.—The table shows 144 visits to 85 flowers. Mas shows 37.6 per cent. of the flowers visited and 45.1 per cent. of the visits. Red shows 35.2 per cent. of the flowers visited, while yellow shows 49.3 per cent. of the visits. *Calliopsis andreniformis*, with 35.4 per cent. of the total visits, shows 29.4 to Mas and 43.1 to red. Separating this species the remaining 15 show for Mas 51.1 per cent. of the flowers and 53.7 per cent. of the visits, and for yellow 53.3 per cent. of the flowers and 67.7 per cent. of the visits. Seven species, *C. coloradensis-P. solidaginis*, show 78.4 per cent. of their visits to Mas and 90.1 to yellow. The last five show 63.8 per cent. under Mis and 44.4 under white. As a rule the visits of the males do not differ much from those of the females, but in *Calliopsis andreniformis* the male shows 5.8 less in percentage of visits to Mas, 11.0 less red and 14.9 more to white.

TABLE I.

	Non-social		Social			Total	Colors		
Flowers observed	Ma 30.1	Mi 24.2	Mas 18.8	Mis 21.5	Pol 5.2	441	R 30.3	W 38.7	Y 30.8
Anthemurgus passiflorae	..	1	..	..	..	1	..	1	..
Zaperdita maura	..	2	..	..	..	2	..	..	2
Verbenapis verbenae	..	.	2	1	..	3	2	1	..
Calliopsis andreniformis	12	9	15	10	5	51	22	21	8
coloradensis	..	.	3	2	..	5	..	1	4
Pseudopanurgus albitarsis	..	..	8	3	..	11	2	1	8
labrosiformis	..	..	10	1	..	11	..	..	11
labrosus	..	..	4	..	..	4	..	..	4
rudbeckiae	..	..	4	2	..	6	..	..	6
rugosus	..	..	7	..	..	7	..	..	7
solidaginis	..	..	4	3	..	7	..	1	6
asteris	..	..	3	5	..	8	1	2	5
compositarum	..	..	4	8	..	12	2	6	4
Perdita octomaculata	..	..	1	5	1	7	..	4	3
Perditella boltoniae	..	..	..	1	..	1	..	1	..
Heterosarus parvus	2	1	..	4	1	8	2	3	3
Total visits	14	13	65	45	7	144	31	42	71
Flowers visited	15.2	15.2	37.6	25.8	5.8	85	35.2	31.7	32.9
Visits	9.7	9.0	45.1	31.2	4.8	144	21.5	29.1	49.3
Calliopsis andreniformis	23.5	17.6	29.4	19.6	9.8	51	43.1	41.1	15.6
Others: Flowers visited	4.4	8.8	51.1	31.1	4.4	45	20.0	26.6	53.3
Others: Visits	2.1	4.3	53.7	37.6	2.1	93	9.6	22.5	67.7
C. col.—P. sol. 7	..	..	78.4	21.5	..	51	3.9	5.8	90.1
P. ast.—Heterosarus 5	5.5	2.7	22.2	63.8	5.5	36	13.8	44.4	41.6
C. andreniformis ♀	21.4	16.6	33.3	21.4	7.1	42	52.3	33.3	14.2
C. andreniformis ♂	20.6	17.2	27.5	20.6	13.7	29	41.3	48.2	10.3

ANTS OF THE GENUS FORMICA IN THE TROPICS

By William Morton Wheeler.

The genus Formica belongs to the northern hemisphere and is best represented in the north temperate or subboreal zone, from which the number of species dimishes rapidly towards the pole and towards the equator. One species, *Formica fusca*, is so eurythermal that it and its many varieties may be said to be nearly coextensive in range with all the remaining species of the genus. Certain data recently accumulated show that through commerce a few of the species have succeeded in establishing themselves in the tropics. These data and the original distribution of the genus are briefly considered in the following paragraphs.

A map of the distribution of the genus Formica shows that it covers nearly the whole of Europe as far north as North Cape, where Sparre-Schneider (1909) has taken it between latitude 69° to 70° N., that is within the arctic circle. In Asia the range is even wider, since it probably reaches the same high latitude and extends as far south as Soochow, China and the Himalayas (28° to 30° N.). A corresponding southward distribution in Europe is, of course, precluded by the Mediterranean. In the New World Formica covers most of the Nearctic Realm. I have shown (1913) that in Alaska *F. fusca* and its varieties *marcida* Wheeler and *neorufibarbis* Emery range at least as far north as 64° to 67°, that is up to Fort Yukon, on the arctic circle. Eastward *F. fusca* occurs on the coast of Labrador, but no Formicidæ are known to exist in Greenland and Iceland, according to Pjetum and Lundhein, cited by Forel (1910). Prof. Pilsud, Director of the Danish Biological Laboratory on Disko Island, on the west coast of Greenland, has recently confirmed this statement in my hearing. The southern range of Formica in North America seems to stop at about 30° in the United States. I have seen no specimens from Florida, but have taken a couple of species near San Antonio, Texas and several along the Mexican border in western Texas, New Mexico,

Arizona and California. Some of these together with a few allied species occur also in Mexico, but apparently only at elevations of about 8000 ft., as far south as Hidalgo in the state of Guerrero (lat. 18°). In all probability the same Formicas inhabit the mountains of the state of Oaxaca and therefore extend the range of the genus to the southern limits of the Nearctic Realm, that is to the Isthmus of Tehuantepec.

Although there would seem to have been every opportunity both in Asia and Mexico for the spread of the species of Formica into the tropics, the only recorded instances of its occurrence are the following:

(1) Bingham in 1903 cites the taking of three workers and a female of the common European *F. rufibarbis* Fabr. by W. L. Distant in Pretoria, South Africa, only a short distance from the tropic of Capricorn (26° S.). This seems to be the only record of the genus occuring in the southern hemisphere. There would seem to be little doubt that the species was imported directly from Europe.

(2) According to Emery *F. fusca* var. *glebaria*, a common ant in central and southern Europe, has been imported into the gardens of Algiers. He calls attention to the fact that this insect does not occur in Crete nor on the smaller islands of the Mediterranean.

(3) In 1913 Forel described a var. *formosae* of *F. picea* Nyl. from Taihorin, Formosa, which is on the tropic of Cancer. *F. picea* is a boreal European ant, usually found in peat-bogs. Forel's variety may perhaps occur at a considerable elevation in the mountains, which in Formosa rise to an altitude of 9000 to 14,000 ft. In this case, therefore, we may be dealing with a relict instead of a recent importation like the two previous cases. Emery believes that the *F. fusca* var. *filchneri* described by Forel from China is really *F. picea*.

I was astonished to find among a fine collection of ants made for me by Dr. J. W. Chapman at Dumaguete, on the island of Negros Oriental, Philippines, several specimens of two species of Formica. One of them, represented by a number of workers, agrees in all respects with European and North American

specimens of the typical *F. fusca*, while the other, represented by four workers, is undoubtedly our common North American *F.* (*Proformica*) *neogagates* Emery subsp. *lasioides* Emery, or rather a slightly darker form approaching the var. *vetula* Wheeler. It seems probable that both these Formicas reached Dumaguete (lat. 9° 30′ N.) from the United States, in merchandise imported for the Silliman Institute, at which Dr. Chapman and several other Americans are teaching.

The actual occurrence of Formica species among the tropical ant fauna is of interest in connection with the composition of certain fossil faunas like that of the Baltic Amber, which is of Lower Oligocene Tertiary age. This fauna consisted to a considerable extent of tropical genera like Tetraponera, Iridomyrmex, Oecophylla, Dimorphomyrmex, Gesomyrmex, Pseudolasius, etc., but, as I have shown (1914), it also comprised several species of Formica and notably one, *F. flori* Mayr, which is very closely related to the existing *F. fusca*. It seemed to me that in the ancient Samland these Formicas must have lived at a greater elevation than the tropical genera, but the existence of Formicas at sea-level in the Philippines seems to indicate that even during lower Oligocene times what is now a north temperate ant-genus may have shared the same habitat as the various tropical forms.

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A NEW JAVAN CHILOPOD OF THE GENUS MECISTOCEPHALUS.

By Ralph V. Chamberlin.

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At Honolulu, Hawaii, a number of millipeds and centipeds were taken on Mar. 8, 1922, from soil of a shipment of plants from the Botanical Gardens of Buitenzorg, Java. Among these specimens, which were submitted to the writer for identification, were numerous specimens, mostly young, of the new species of Mecistocephalus described below. This form belongs to the lesser group of species in which the sternal impressions are not furcate anteriorly, and apparently has its nearest relatives in *M. apator* Chamberlin and *M. monticolens* Chamberlin, previously described from the same region. Two other chilopods were in the collection, *Otostigmus fœx* Pocock being represented by one specimen, and a species of *Lamyctes*, not in identifiable condition, by another. Two diplopods were represented, *Trigoniulus lumbricinus* (Gerstæcker) and *Oxidus gracilis* (Koch), the latter being a species long ago introduced into this country and Europe and often known as "the hot-house milliped."

Mecistocephalus tridens sp. nov.

Head and prehensorial segment chestnut, the remaining parts yellow.

Head wider than long in the ratio 14:9. Widest anteriorly and narrowing caudad, more abruptly so over caudal fourth of length, the general narrowing less marked than in *apator*. Anterior margin nearly straight, much as in *apator*.

Clypeal region with no anterior, non-areolated areas. With six principal setæ arranged as in *monticolens*, the sublateral teeth being also nearly of same from as in that species.

General outline of labrum as in *monticolens*, but the median piece narrower and about as wide behind as in front with the

sides a little concave. Caudal end of median piece straight and weakly tridentate. Anterior margins of lateral pieces concave, bending more strongly forward toward mesal ends. Caudomesal angles of lateral pieces a little produced, their apices on a level with caudal end of median piece.

Prosternal teeth small and acute. The usual teeth present on joints of prehensors, the distal one of femuroid being largest; all oblique and rather slender though distally rounded.

Sternal impressions not furcate anteriorly.

Ventral plate of pregenital segment strongly narrowed caudad, trapeziform. Coxal pores on each side small, moderate in number.

Pairs of legs, 49.

Length, 20 mm.

Cotypes in Museum of Comparative Zoology and in collection of The Federal Horticultural Board.

A UNIQUE METHOD OF DEFENSE OF *BREMUS* (*BOMBUS*) *FERVIDUS* FABRICIUS.[1]

By O. E. Plath,

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It is a well-known fact that bumblebees, especially the more ferocious species, are quick to attack with sting and mandibles if any vertebrate ventures too close to their nests. Similar punishment is meted out by many species if their nests are invaded by bees which do not belong to the colony, *e. g.* Psithyrus.[2] In this case the fate of the intruder may be shown by describing briefly the behavior of a fair-sized colony of *Bremus impatiens* Cresson when a queen of *Psithyrus laboriosus* Fabricius enters, or is placed in, its nest. As soon as the stranger is detected on or near the comb, a general uproar arises in the colony. The intruder is seized immediately by numerous workers, stung to death, and thrown out of the nest. This, in general, seems to be the behavior of a large number of Bremus species whose habits have been studied. But, as we shall see presently, one of our most common New England bumblebees, *Bremus fervidus* Fabricius, behaves very differently under these conditions.

During the summer of 1921, the writer had under observation 13 colonies of bumblebees belonging to the following species: *Bremus affinis* Cresson, *Bremus bimaculatus* Cresson, *Bremus fervidus* Fabricius, *Bremus impatiens* Cresson, and *Bremus vagans* Smith. Each colony was kept in a glass-covered box which was provided with a flight-hole so that the life of the colony could go on unhindered. On July 24th, the writer noticed a disheveled *Psithyrus laboriosus* queen crawling out from the nest material of colony No. 7 (*B. fervidus*) and removed her to a separate box. She was wet all over, her pile being matted against the integument by a sticky liquid. On the same day a worker of colony No. 8 (*B. impatiens*) which had been placed near

[1]Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 206.

[2]A genus of bumblebees whose members are social parasites on various species of the genus Bremus, the industrious branch of the bumblebee family (Bremidae).

colony No. 7 (*B. fervidus*) the preceeding evening, was found sitting near the entrance of her nest and, like the Psithyrus queen, was completely covered with a sticky liquid. Whenever this worker attempted to enter the nest, she was immediately attacked by her sisters and driven back. The reason for this strange behavior and the source of the sticky liquid, which the writer at first was unable to account for, were disclosed several days later.

On July 27th a captured *Psithyrus laboriosus* queen was placed in a *Bremus fervidus* nest and the writer was surprised to find that the workers, instead of creating a furore and killing the Psithyrus, as do the workers of *Bremus impatiens*, remained calm and resorted to a more peaceful, but equally effective, method of expelling the intruder. About a dozen workers gathered about the Psithyrus queen, and, after stealthily approaching a little closer, each one placed a small drop of liquid on the intruder with her mouth. The Psithyrus queen did not seem to relish this performance and slowly left the comb, apparently seeking to hide herself. A number of workers followed her and from time to time added more liquid until she was as wet as the Psithyrus queen and Bremus worker referred to above. The experiment was repeated with other *fervidus* colonies and was later (September 13th) demonstrated before the Cambridge Entomological Club. The members of the club were also shown the very different behavior of a *Bremus impatiens* colony under these conditions.

From July 27th to September 24th a large number of other experiments were carried out in order to determine how colonies of *Bremus fervidus* react to other intruders. These experiments may be summed up briefly as follows:

Experiment 1. Introduced: Young queen of *Psithyrus ashtoni* Cresson.

Result: Daubed with liquid like *Psithyrus laboriosus*. No attempts to sting her.

Experiments 2, 3, 4 and 5. Introduced (separately):

Workers of *Bremus affinis*, *bimaculatus*, *impatiens*, and *vagans*.

Result: Same as in experiment 1.[3]

Experiment 6. Introduced: Worker from another *fervidus* colony.

Result: Attacked with legs and mandibles. No attempt at daubing.[4]

Experiments 7, 8 and 9. Introduced (separately): Worker honeybee (*Apis mellifica*), male of *Bremus impatiens*, and male of *Polistes pallipes* Lepeletier.

Result: All stung to death and thrown out of the nest. No attempts at daubing.

Experiments 10, 11, 12, 13 and 14. Introduced (separately): Blue bottle fly (*Calliphora vomitoria*), drone fly (*Eristalis tenax*), dragon fly (*Sympetrum rubicundulum*), small cricket (*Nemobius sp.*), and gypsy moth (*Porthetria dispar*).

Result: Same as in experiments 7, 8, and 9.

Experiment 15. Introduced: Katydid (*Conocephalus sp.*).

Result: Stung to death, but also daubed.

Experiments 16, 17, and 18. Introduced (separately): Earth worm (*Lumbricus sp.*), young frog (*Rana sp.*), and mouse (*Mus musculus*).

Result: All stung to death. No attempts at daubing.

From these experiments it will be seen that the workers of a *Bremus fervidus* colony, at least when dealing with insects, vary their method of attack with the nature of the intruder. If stingless, or comparatively weak (*e. g.*, the honeybee), the intruder is seized immediately and stung to death, while daubing is invariably resorted to if the intruder possesses superior fighting ability. What enables *Bremus fervidus* to make these distinctions, it is difficult to say. In this connection it must be stated that

[3]In connection with experiment 4 it may be stated that a worker of *Bremus impatiens*, an exceedingly pugnacious species, sometimes attacks a *fervidus* worker, and may then be stung to death by one or more workers of the latter species, though other members of the colony, even during the struggle, continue to daub the intruder.

[4]Similar results obtain if two *fervidus* colonies are combined. During the course of the summer, the writer made four such combinations (one colony in each case being queenless), but never noticed any daubing.

bumblebees never molest certain intruders, *e. g.* the larvæ of Brachycoma, even though the latter are very deadly to their brood.

At first there was some doubt as to the nature of the liquid which *Bremus fervidus* uses in connection with this interesting behavior, but the writer finally decided that it is honey. This conclusion is based on the following facts: (1) the liquid has a sweet taste; (2) a young *Psithyrus ashtoni* queen which was being daubed (experiment 1), lapped up a drop of liquid which accidentally adhered to some cotton; and (3) the *fervidus* workers themselves lapped up the liquid from the wings of a katydid (expirement 15) after the latter had been stung to death.

This habit of daubing certain intruders with honey recalls an interesting habit of the honeybee. According to Phillips (1921, p. 117), it sometimes happens that lizards or small snakes get into a hive. The honeybee workers seal up such intruders in propolis, a sticky substance which they obtain from trees and other sources. Because of the different nature of the substances used, it seems rather improbable that the habit of the honeybee and the habit of *Bremus fervidus* are related, yet it would be interesting to know whether there is any similarity in behavior while the substances are being applied.

It would also be interesting to ascertain whether any other species than *Bremus fervidus* resort to honey daubing. The writer found no trace of such a habit in his *affinis*, *bimaculatus*, *impatiens*, and *vagans* colonies. Nor is such a habit mentioned by Goedart (1700), Réaumur (1742), Huber (1802), Putnam (1865), Hoffer (1882-83), Kristof (1883), Coville (1890), Härter (1890), Bengtsson (1903), Lie-Petterson (1906), Wagner (1907), Gundermann (1908), Sladen (1912), Armbruster (1914), Bachman (1916), and Frison (1917, 1918), all of whom have paid more or less attention to the behavior of bumblebee colonies. However when we consider that Putnam (1865), who had colonies of *Bremus fervidus* under observation, did not notice this habit, it may well be that it was overlooked in other species.

According to the classifications of Franklin (1912-13) and Sladen (1912), one based on structure and the other on habit,

Bremus fervidus belongs to the Dumoucheli group and to the Pocket-makers, and it therefore is among the representatives of these groups that we should look first for species which are given to honey daubing.

As already mentioned, Bremus colonies are occasionally infested by parasitic bumblebees of the genus Psithyrus. According to Hoffer (1888, p. 132), this sometimes occurs in almost every second colony of certain species. Other Bremus species, on the other hand, never harbor these parasites (Cf. Sladen, 1912, p. 257), and this, as the writer pointed out recently (1922), also seems to be the case with *Bremus fervidus*. It can hardly be doubted that the honey daubing habit of *Bremus fervidus* plays an important role in keeping Psithyrus from breeding in its nests.

In his "Catalogue of British Hymenoptera" Smith (1855, p. 210) makes the following statement in regard to the apparent immunity of certain English Bremus species from Psithyrus infestation: "Although I have taken or examined a very large number of the nests of Bombus [Bremus], I have only occasionally met with the parasites [Psithyrus] in them; but never in the nests of the brown bumble-bees." All of these brown species to which Smith refers (*agrorum*, *distinguendus*, *helferanus*, and *muscorum*), like *Bremus fervidus*, are Pocket-makers. However, Hoffer (1888, p. 132) found that in Austria two of these brown species (*agrorum* and *helferanus*) are frequently victimized by*Psithyrus campestris* Panzer, and Wagner (1907, p. 78) reports that in Russia *Bremus muscorum* suffers severely from the depredations of various species of Psithyrus. *Bremus distinguendus* Morawitz, the other species mentioned by Smith, is very similar to *Bremus fervidus* in structure,[5] coloration, and habit. It is also very closely related to *Bremus latreillellus* Kirby[6] so that Morawitz (1881, p. 238) and Friese and Wagner (1910, p. 75) merely look upon it as a variety of the latter. According to Sladen (1912, p. 257), *Bremus latreillellus* is not preyed upon by any species of Psithyrus; nor has any

[5]Cf. Sladen (1912, p. 187) and Franklin (1912-13, I, p. 392).

[6]Cf. Hoffer (1882-83, II, p. 72); Radowszkowski (1884, p. 77); Sladen (1912, pp. 184, 187); d Lutz (1916, p. 503).

Bremus distinguendus colony ever been reported as victimized by a Psithyrus. These facts lead the writer to surmise that *Bremus distinguendus, latreillellus,* and perhaps also *Bremus fragans* Pallas, may prove to be "Honey-daubers."

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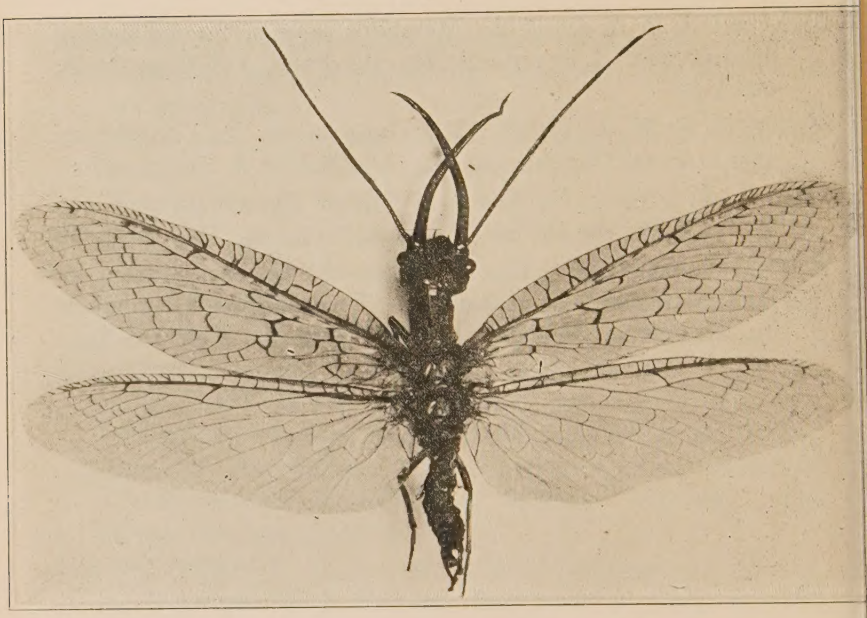

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